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Grain Sanitation Program for Elevators

By M. S. Buckley

THE recent announcement by the Food & Drug Administration of its proposed program of inspection of terminal and country elevators has caused a considerable amount of concern to the grain trade. The business of handling grain has, in years past, overshadowed thoughts of sanitation particularly at the country elevator level. The purpose of this article is to present general principles of sanitation which will serve as a guide to elevator men in cleaning up their own back yards.

A similar program was introduced to the milling industry about five years ago and as an industry it has done an excellent job. This progress was not accomplished overnight and was not accomplished by minor expenditures. The most important change was in the attitude of the milling industry. The Food & Drug Administration received excellent cooperation and once the standards were established the mills carried the program on through their own initiative rather than being constantly forced into action by FDA.

First: Cooperate with FDA

The best single piece of advice which can be given to the grain trade is this: Do everything in your power to cooperate with the FDA. At times this may seem hard to do. If at any time its inspectors recommend a certain measure be taken that is impractical or creates an undue hardship, sit down and talk it over with them. They are reasonable people and are not going to insist on measures which are not in accord with good commercial practice.

Inaugurating a program of sanitation consists of outlining the work to be done in simple logical steps, as follows: General cleanup and housekeeping measures, insect control, rodent control, and routine inspections which will reveal the progress made in each of the above categories and serve as a periodic condition report.

In establishing these inspection procedures, it is well to have some individual do the inspecting who is not employed at the particular site being inspected, as a stranger who knows what to look for will observe conditions that a person familiar with the premises may overlook.

In order for the survey or inspection to be of value it must be thorough and complete, including both inside and outside, and be detailed enough to include suggested improvements or corrections to be made. It may be well to have forms made which cover the various check points of the plant being inspected since there may be many places to be noted which may be peculiar to a given plant. The forms may be made after having made several thorough inspections of the entire plant operations and it might be well to divide them into several parts such as outside elevator, inside, cleaning section, pit, head house, etc.

In setting up an inspection program, the first thing to consider is the outside premises. Check the surroundings for piles of accumulated trash, junk, machinery, old spouting and broken and discarded equipment; piles of spilled and souring grain, and grain doors. Are there trash, paper and grain accumulated around the unloading pit and under the scales? Is the area where cars are cleaned and coopered littered with trash, broken grain doors, etc? Have weeds been allowed to grow around the tanks and along the tracks and on other parts of the plant property providing cover for rodents? Is a suitable place provided for the burning of trash?

Grain doors are a necessary evil around an elevator. In order to operate in an efficient manner it is necessary to maintain an adequate inventory of grain doors, particularly at a country station where the bulk of grain received is trucked in and grain doors will be needed for outbound shipments.

Excellent rodent harborages are provided by stacks of grain doors being piled on the ground. In order that rodents will not harbor under grain doors it is necessary to place them on suitable stands or racks at least 18 in. above the ground. At this height the rodents do not feel secure enough to establish quarters. Look for quantities of spilled grain around the unloading pit, as well as accumulations of trash and evidences of rodent activity.

Eliminate Rodent Harborages

As you are making the rounds, inspecting the outside look for signs of active rodent infestation as well as places where rodents are entering the building. Make notes of active rodent burrows, check windows, particularly at first floor and basement level to see if they are properly screened to prevent rodent entry. Screening should be ¼ in. hardware cloth in order to keep out both rats and mice.

Check the water drainage away from the elevator and around the pit and wheat dump. Any source of water can provide drinking places for rodents, so eliminate standing pools of water due to poor drainage. Rodents can drink stagnant and filthy water and eat spoiled and decaying foods with no apparent harmful effects.

"Build and Starve Them Out"

The whole story of rodent control can be summed up very briefly: Build them out. Starve them out. Check thoroughly other places of entry such as open and unscreened windows, cracks in foundation or walls which may give access to rodents. Remember this rule in determining whether or not rodents can enter: Any hole large enough to get your thumb into will allow a rat to get in. Holes in walls where electric wires or pipes pass through are often common places of entry. Rodent-proof such places with metal shields, cement or hardware cloth, whichever suits the particular situation.

After having made a thorough inspection of the outside the next step is inside the elevator itself.

Examine the pit first. In the case of a country elevator this consists of a small hole large enough for an elevator leg and spouts from the bins to the elevator legs. In terminals this area will include wheat dumps, elevator legs and one or more belt tunnels depending on the size of the elevator.

In the pit a flashlight will be needed to examine carefully along the edges of the walls and particularly around the dump for signs of rodent activity. Look for tracks in the dust and for the presence of pellets. If the pit or tunnel should have a dirt floor, check for the presence of rodent burrows. Move old pieces of equipment and parts, etc., away from corners and look for the tell-tale pellets.

While in this area check on the general housekeeping. Is the equipment in good repair? Are the boots tight and not leaking grain? Have rags and sacks been tied around spouting to stop leaks? The temporary repair of a spout by tying a sack around it is necessary at times. This method of repair, however, too often becomes permanent. Just like the proverbial leaking roof, when it's raining it can't be fixed and when it's not raining it doesn't need repair. This is a sloppy way of taking care of equipment and proper repairs should be made at the earliest possible moment. Dust and grain caught and held by the sack or rag are excellent breeding places for insects, providing a constant source of infesting grain. Check for piles of souring grain as these areas are often damp. Arrangements should be made to have such leakage cleaned up at the end of each day's operation or at least at the end of each shift.

In a larger elevator where a conveyor belt is used to transfer the grain from the tanks, examine under the entire length of the belt for signs of rodent and insect activity. When rodent tracks are observed, try to follow them and locate their place of entry. In addition to checking for signs of rodent and insect activity, observe the general housekeeping practices. Is there sufficient suction to carry off the dust. If not, make note of it. While a deficiency such as this may not be remedied overnight, it is one which should be given priority since it not only creates insanitary and unhealthful working conditions, it is also very dangerous from the standpoint of creating a potential explosion hazard.

Lower levels such as these are also favorite harborages for roaches. Be sure to check all cracks and crevices for their presence.

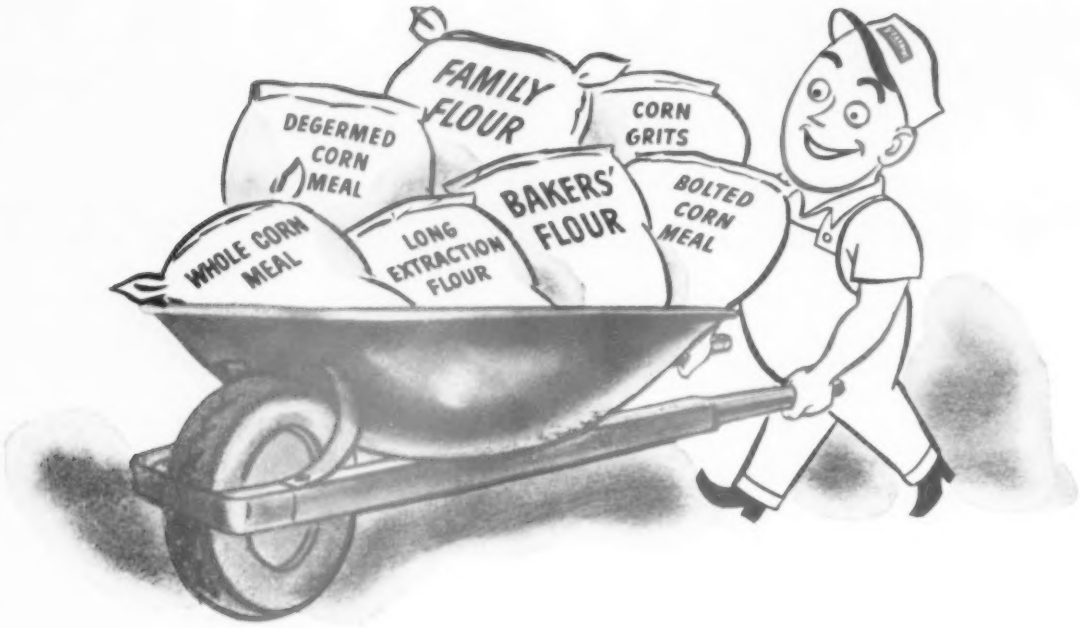
Often the spouts under bins will have small deposits of grain hung up, particularly around the valve mechanism, such deposits, if not removed, frequently offer another source of infestation.

Get Rid of Scrap, Debris

Proceeding upward in the elevator, observe the general housekeeping, paying particular attention to corners where junk, used machinery, old sacks and parts have been allowed to accumulate. Get rid of all unnecessary materials of this sort. If some parts and tools are used periodically have proper storage racks built to contain these materials.

Inspect the cleaning machinery and observe the tailovers. Are they allowed to spill out directly on the floor and fill up spaces under the cleaner? Where it can be done practically, these tailovers should be spouted to a sack or other suitable container and the material disposed of frequently enough so that the container will not overflow. All too frequently accumulations from leakage or from tailovers are allowed to remain under equipment for long periods, becoming highly infested. Unfortunately in many cases such accumulations are allowed to build up until they cannot

(Continued on page 17a)



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A Replacement for the Ash Test as a Measure of Flour Quality

By Dr. D. W. Kent-Jones

ABOUT THE AUTHOR—Dr. Kent-Jones is an internationally recognized cereal chemist, presently associated with Dr. J. A. Amos in the operation of a laboratory and consulting service in Great Britain. He has been a frequent visitor to the U.S. and has appeared on programs of a number of conventions of the American Association of Cereal Chemists. The accompanying article was prepared by Dr. Kent-Jones for publication in this journal.

WHEN the chemist, many years ago, first entered into what had always been until then the art of milling, there were two problems which were outstanding. Some flours made better and bolder bread than others and were described as strong flours. The chemist therefore wanted to know why some flours had better "bakeability" and immediately attention was directed to the quantity and quality of the protein and of those proteins which were responsible for the characteristic gluten which determined the nature of the dough. Secondly, some flours were whiter and brighter than others and there was a commercial premium for these better grade flours, as they were called. How could grade be determined with precise and scientific accuracy? It was soon realized that dull flours of poor quality and grade contained excessive bran, generally in the form of bran powder, i.e., they contained an abnormal amount of the powdered outer coverings of the wheat. It was then found that the mineral content of the outer coverings of the wheat, unmixed with the white inner endosperm which was the backbone of the flour, had a high ash content.

Indeed the ash content of the outer coverings of the wheat was as high as 8%, while the ash content of the pure endosperm, the basis of the flour was very much lower, say around .30%, both figures being based on the materials as they were with no allowance being made for the moisture present. The ash content of a flour, or for that matter of any milling stock, therefore gave an indication of the percentage of outer coverings of the grain present in the flour, stock or cereal material being examined and hence of what was commercially known as the grade.

As regards commercial flours, the value of the ash content quickly became realized and, as the test was one which could be made with a high degree of precision so that the agreement between various analysts was, on the whole, good, great reliance and importance was placed on the test.

It was substantially the only acceptable test for commercial grade and the ash test tended to acquire an importance rather beyond its real value. The problem was further obscured by the fact that the presence of powdered bran in flour not only increased the ash content and lowered the color and the grade, but often the excessive proteolytic enzymes, which are more highly concentrated in the bran than in the endosperm, also caused a falling off of the "bakeability."

However valuable the ash test, it was gradually realized that, as a test for grade and color, it was far from perfect. Yet before other tests were known, it was of considerable value. It was only when the value of the ash test was exaggerated that difficulties arose. Because, from any one wheat or grist, the low ash content patent flours made bolder and more pleasing loaves than the higher ash content lower grade duller flours, undue importance was placed on the ash content. Flours were sold on ash content and it was quite forgotten that, in certain circumstances, one flour of slightly lower ash content than another, might not be as bright and pleasing.

Exaggerated importance was thus attached to the ash content. It is by no means true that the ash content of the pure endosperm of all wheat is the same. Thus the ash content of a straight run flour contaminated with X% of bran powder might be higher than the ash content of another flour contaminated with X+Y% of bran powder because the ash content of the endosperm of the first might be higher than that of the second.

The usefulness of ash tests has undoubtedly been grossly exaggerated and it has hence become misleading instead of being helpful. This is simply because the ash test is an indirect and not a direct determination of grade, brightness and color and all those attributes associated with grade, brightness and color. Its excessive advocacy by the cereal chemist has indeed not redounded to his appreciation by practical millers and bakers. It is not surprising, therefore, that the false importance placed by some on the ash content of flour has brought forth diatribes on the "Tin God Ash."

In this connection, attention has been recently directed to the matter by a leading cereal chemist in U.S.—George Garnatz. Recently he has said:

"All through the comment on flour grade runs the feeling that the ash test operates under limitations in defining this factor. It is charged with contributing to false values, economic penalties in the mill and the rejection of good milling and baking wheat simply because the mineral matter content of the wheat is high. Despite the efforts and the failures of the past, further effort is warranted. It is just possible that, with advancing knowledge and experience, along with new tools, the time may be right to uncover a method which, with fidelity and acceptable accuracy, will define flour grade."

This problem had already attracted the attention of the writer and those associated with him in his laboratory in which is examined each week several hundreds of flours from the majority of the mills in Great Britain. Ash content, it was realized, was not a reliable test for flour grade and hence some 20 years ago, suggestions were made for the determination of grade by means of color determinations (Kent-Jones & Herd 1927). However, there has only comparatively recently been devised a test and an apparatus which will register flour color, as determined by grade, quickly, simply and with reliability.

This test and apparatus have now been operated daily in over a hundred mills for over a year by critical millers and chemists and, as a consequence, European millers have considerable faith in the method. The apparatus, known commercially as the Kent-Jones & Martin Flour Color Grader, may well be the answer to the problem so concisely expressed by Mr. Garnatz.

The instrument utilizes a balanced circuit containing two photo-electric cells to measure the amount of light of a particular wavelength which is reflected from the surface of a paste prepared from the flour or material under test.

The amount of light reflected is recorded as a proportion of the amount of light of the same wavelength which is reflected from a standard white surface (heavy magnesium oxide).

The determination is performed on a suspension or a paste of the flour contained in a special glass cell. This eliminates any effects due to granularity.

It has been established that the light reflected from the surface of a flour paste which is transmitted by a filter (whose main transmission is in the 530μ wave band) is not influenced to any appreciable extent by the degree of bleach imposed upon the flour, whether natural or artificial.

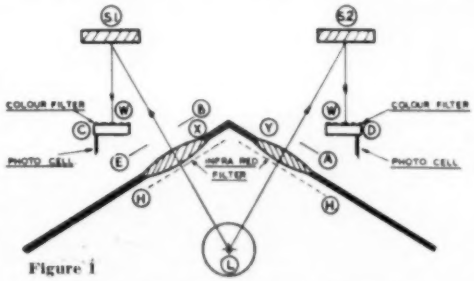

Figure 1

(A) Cut-off, operated by cam control shown in Fig. 2. (B) Set zero shutter operated by knob K in Fig. 2. (C and D) Photo-electric cells. (E) Adjust zero control operated by knob J, Fig. 2. (H) Heat absorbing infra-red filters. (L) Lamp. (S1 and S2) Standard surfaces. (W) Special glass color filters to control wave length of light. (X and Y) Lens systems.

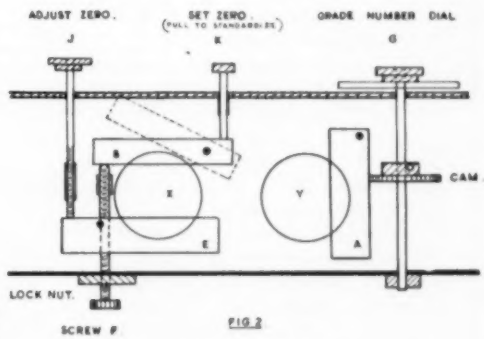

FIG 2

CONTROL ARRANGEMENT

Thus, the amount of light transmitted by the filter is dependent only upon the grade of flour, i.e., upon the amount and nature of the bran.

The apparatus and technique described enables the operator, uninfluenced by personal judgment, to assess the flour color quite as accurately as can the experienced and skilled miller and baker; moreover the operator can record the value numerically.

The apparatus was first described by Kent-Jones & Martin in 1949 and concurrently Kent-Jones, Amos and Martin reported results of experiments using the test and analyzed statistically the results so obtained. It was pointed out that flour color is controlled mainly by:

1. The grade of the flour, which depends upon the extent of the contamination of the ground-up endosperm by fragments of the outer coverings of the grain, i.e., bran and associated substances.

2. The degrees of yellowness due to the amount of the natural yellow coloring matter present and the ex-

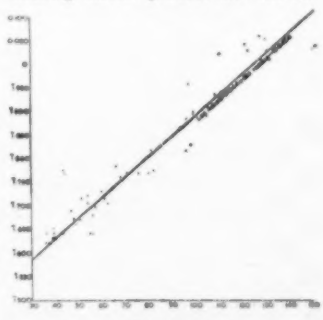

Figure 3

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tent to which this has been removed by natural and artificial bleaching or by both.

3. The granularity; the more granular the flour the darker and duller it appears. Dullness from this cause will not persist in the crumb of the resulting loaf.

4. The presence of dirt, smut and other extraneous matter.

The problem of the accurate recording of the degree of yellowness is comparatively simple as the coloring matter can be easily extracted by certain solvents and measured by recording the depth of the color in the solvents. The recording of the grade color was, however, a much more difficult affair and it took several years' work to evolve a quick, simple and reliable method and apparatus.

Perhaps it is simplest to quote portions of the papers, already written, which describe the apparatus and the test.

In the brochure of working instructions of the Flour Color Grader, the apparatus is described as follows:

"The apparatus (Fig. 1) consists of a light source L which is provided by a short filament - 12-volt, 36-watt lamp, fed from AC mains supply via a tapped transformer contained in the instrument case.

"This lamp projects light through the lens systems X and Y which are designed to give parallel light, on to two standard surfaces S1 and S2. The two standard surfaces are the clear glass fronts of two glass cells which are approximately 5 cms. square and 1 cm. thick and which are filled with specially prepared heavy magnesium oxide.

"Light reflected from the front plates of the two standard cell surfaces is received by the two photo-electric cells C and D. Immediately in front of each photo-cell is a special glass filter having its main transmission in the 530μ wave band.

"The photo-cells on to which the light is reflected are connected in the usual way to a galvanometer with a tapping key in circuit so that the null point can easily be obtained.

"In front of lens X (Fig. 1 and 2) is a shutter B operated by a knob K (marked set zero in Fig 2). When K is raised a fixed portion of the light beam passing to cell S1 is cut off. This is incorporated because of the marked difference between the standard surface and the surfaces presented by flour pastes.

"If this cut off were not used the calibrated dial G (Fig. 2—grade number dial) would have to be rotated considerably before the null point was reached, hence an appreciable portion of the scale on dial G would be wasted even on high grade flours.

"By suitable adjustment the amount of light cut off by the set zero control K which can be altered by adjusting screw F (Fig. 2) the range of the instrument can be altered to suit materials being tested.

"The second shutter E is also in front of lens X (Figs. 1 and 2). This is operated by a rotatable knob J and is used to effect the initial balance of current, which causes movement of the light spot after the set zero knob K has been pulled into the raised position.

"In front of the other lens Y (Figs. 1 and 2) is a cutoff screen A operated by the calibrated dial G. This is operated through a linear cam, the total movement of which is very small.

"To eliminate any small effect due to infra-red rays from the lamp, there has been incorporated in the light path of the instrument a special glass indicated as H in Figure 1; this glass has the power of absorbing a high proportion of the infra-red rays. Normal mains fluctuation does not call for the use of a stabilizing transformer but if mains supply is rather abnormal a transformer of this type might be necessary."

The instrument is operated as follows. First switch on the lamp and allow the instrument about 20-30 min. to "warm up."

Then raise the "set zero" control K, thereby cutting down by a predetermined amount the light falling on the standard surface S1 and thus on the photo-cell C.

Weigh out approximately 30 grams of the flour (to within ±0.25 g.) to be tested, add approximately 50 ml. of distilled water (to within ± 1 ml.) and stir into a smooth and homogeneous paste. Make certain that the clear glass reflecting surface of the sample cell is absolutely clean and then pour the paste into this cell while the cell is held at approximately 45° with the clear glass face downwards so that any air bubbles will rise to the frosted side of the glass cell. This insures that the reflecting surface, i.e., the clear glass surface, is free from air bubbles.

Set the dial G at zero and balance the photo-cells by adjusting the zero control J (Figure 2) until, on using the galvo tapping key there is no movement of the galvanometer light spot; this indicates that both cells are receiving the same amount of light.

Remove the left standard cell S1 from the balanced instrument and replace by the cell containing the sample. Depress the "set zero" control K, which then allows the full amount of light to fall on the sample cell, and rotate the calibrated dial G from its zero setting, cutting down the light from S2 until a null point is obtained on the galvanometer, indicating that both cells are again re-

ceiving the same amount of light. Take the dial reading without undue delay although an interval of a few minutes is not likely to affect the reading.

The advantages of the method are many. First of all it is not like the ash test, an indirect measurement of color as affected by grade. The test is simple and quick to perform (taking only 4 to 5 min.); experimental error is reasonably low and duplicate tests done on different instruments by different operators in different mills are closer than many expect, provided care is exercised and the instrument properly operated and kept clean. All instruments are standardized and calibrated before being sold and complete records are kept of each instrument.

Before giving a table illustrating the closeness of results by different operators using different instruments, the empirical scale used in Great Britain should be explained. The readings are obtained directly on the dial which operates the cam shown in Figure 2. Readings are taken to the nearest .5 main unit on the dial, since it is only just possible to distinguish visibly a difference in color due to .5 Kent-Jones & Martin unit.

Top patent flours register on the scale used figures of about 1 to 4, i.e., 1 to 4 Kent-Jones & Martin units; 72% straight run flours vary from about 4.5 to 6.5 and 80% extraction flours milled in Great Britain 7.5 to 8.5.

When 85% flour was made, the range in commercial flours was from 9.5 to 12.5. The empirical scale can be altered and expanded, if so desired, so as to differentiate with more precision between various white flours; this only entails a lowering of the cam but, of course, the experimental error is also increased and no service is performed in making the machine so sensitive so that it attempts to indicate differences in color beyond those which can be recognized visually by the skilled and experienced miller.

In the paper by Kent-Jones, Amos & Martin in the Analyst, a series of flours (50) was used and careful determination made both of the ash and of the Kent-Jones & Martin units. The regression of log ash on dial reading was found to be:

Log ash = .0044 × dial reading — .5454 and the regression line is shown in Figure 3. The correlation coefficient between dial reading and ash content was high at .959 but, as the ash is not a correct assessment of color, two flours of significantly different ash contents may furnish the same dial reading and conversely two flours of identical ash may yield significantly different dial readings.

Attention is drawn to the fact that the Kent-Jones & Martin figure is determined on the flour in paste form to overcome difficulties due to granularity and to the use of light of the wavelength approximately 530μ so that the same flour, bleached or unbleached, gives substantially the same grade color figures. This is of considerable value since the Kent-Jones & Martin Grade Figure does not alter on storage although bleaching slowly takes place.

The table given below shows the result of a few of the many collaborative tests made on samples by different operators using different machines and often in different countries.

Table 1—Three Different Instruments in Different Mills in Great Britain

Flour	Mill 1	Mill 2	Mill 3
A	8.6	8.6	8.7
B	8.2	8.2	8.2
C	7.6	7.7	7.6
D	7.1	7.3	7.1

Comparison of Instrument at a Testing Research Station With Author's Standard and Routine Instruments

Flour	Testing station	Standard instrument	Routine instrument
1	8.9	9.0	9.0
2	8.6	8.4	8.4
3	8.2	8.2	8.3
4	7.5	7.2	7.3
5	8.6	8.2	8.2
6	7.9	7.8	7.7

Comparison Between Two Continental Instruments

Flour	First instrument	Second instrument
7	5.0	5.0
8	5.5	5.3
9	7.4	7.7
10	10.0	11.0
11	12.7	12.6
12	15.2	14.7
13	21.5	22.2

Comparison between author's instrument and an instrument in a French mill after being in operation for a year. The ash figures on these flours are also given.

Flour	French mill's results		Author's results	
	Ash %	Grade figure	Ash %	Grade figure
1	0.44	3.5	0.40	3.6
2	0.53	5.0	0.48	4.9
3	0.65	7.6	0.61	7.6

The deviation becomes more marked as the darker flours are examined but the proportionate error is not high and in general the above table, taken at random from correspondence, shows that the readings

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From February MILLING PRODUCTION:

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Engineer Says It Has Possibilities for Grain Drying

A RESEARCH engineer of the U.S. Department of Agriculture believes that radio frequency — dielectric — heating may eventually be useful in drying grain to safe storage moisture content.

The engineer, Finis T. Wratten, believes that dielectric heating also has further possibilities in its effe on bacteria mold spores, inse and enzymes, all present-day stor problems.

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The equipment we have designed will dry grain at a saving and speed never before approached! We urge you to obtain the details on the application of dielectric heating to the grain drying and grain infestation problems. Address all inquiries to M. P. Collom & Sons, 408 S. 3rd St., Minneapolis 15, Minn.

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are substantially within the .5 unit claimed. Naturally instruments can become out of line, especially if allowed to become dirty.

This method of measuring color as determined by grade has already replaced routine ash tests in many mills and it is an extremely useful guide for the practical miller. Just as the eye measures by the reflection of light from flour in a Pekar test and is able to record the colors of flours, so does this balanced photo-electric system record accurately and very quickly the light reflected from flour in paste form and the results are not influenced by the personal evaluation of the operator. The flour (grade) color remains the same even as the flour bleaches on aging and this numerical evaluation of the brightness factor checks up with the visual brightness of the crumb of the loaf.

It is believed that this procedure or other similar systems will be much more valuable to the miller than the ash test and will gradually replace the latter test throughout the milling world. It already has done so in many mills in which the method has been tried out. Many practical millers and cereal chemists in Europe believe the test to be the most practical and striking advance in recent years for mill and flour control and undoubtedly the matter will attract much attention and discussion in the next few years. It seems likely that the new test for color, as affected by grade, will be as routine a test in the near future as the other routine tests now used by the cereal chemist, such as the protein and maltose tests. Many large bakers now rely upon this test to check out their deliveries of flour, finding the test of more practical use than the older and longer ash test, which itself is open to more error than is often realized.

It is, of course, possible that some improvements in design and manufacture will be effected; it is essential to keep the instrument clean and any minor changes in design which assist in this and any alterations which help to secure improvement in standardization and maintenance of this will be helpful, although in practice there has been little adverse criticism from critical users, such as the Flour Millers Research Assn. and the Government Laboratory in Great Britain, who have used the instrument for over a year.

Patents protecting the instrument and the procedure are being taken out in all principal countries.

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One of the foremost scientists and mathematicians of antiquity, Archimedes is best remembered as the discoverer of the law of Specific Gravity.

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Safety Program for Grain Plants

EDITOR'S NOTE: The following paragraphs are a summary of a round table discussion by the grain handling and processing division of the food section at the National Safety Council's National Safety Congress. The leader of the discussion was LeRoy J. Collins, safety director, Spencer Kellogg & Sons, Inc., Buffalo.

AFTER brief introductory remarks by the chairman, the problems in accident prevention placed on the agenda were brought forth for general round table discussion. The problems presented were: What can be done to make sure belt guards are replaced following maintenance or repair?

Recommendations were: Guards were hinged at the top so after repairs were completed they could be dropped back into place. Some plants have a standard incentive program where if a guard were left off, repairmen would receive a penalty resulting in a monetary loss. This system brings about good results.

Further, safety painting using con-

Paul W. Hodler

DIRECTOR—Paul W. Hodler has been named director of the newly formed products control department for Loblaw, Inc., Buffalo, a grocery chain operating in New York and Pennsylvania. Mr. Hodler, for the past 10 years, was associated with the Kroger Food Foundation and more recently with the products control laboratory of that company in Cincinnati. He is a graduate of the department of milling industry, Kansas State College, with a major in cereal chemistry.

trasting colors with high visibility are used successfully in some plants. Also, improved design so repairmen can easily replace guards was advanced as a solution. Many guards are so heavy and poorly designed that extra help is required to replace them.

The second question concerned the hazards of deep tank cleaning and entry of grain bins. Recommendations were: Necessary precaution must be taken to make sure there is enough oxygen to sustain life and also to test for air contamination. Many types of hoists and safety belts are used.

The Gardner-Denver 450-ft. cable electric hoist equipped with a transmission has been used to lower workers into deep grain bins. The Buckingham Belt Co. manufactures a chair or boatswain's seat which keeps the man in a sitting position. This prevents the man from getting out of the seat while he is inside the bin.

Bin dischargers with rotating arms have been used with fair success in medium-size hoppers. Forced ventilation is used by some plants during these operations. Coppus blowers or a hose attached to a compressed air line are used to a good advantage.

Also, some plants have a definite procedure to be followed for tank cleaning operations; such as flushing the tank with a large volume of water first and testing the air for H_2S using lead acetate paper. Self-contained oxygen masks and fresh air hose masks are also required for those men who perform tank cleaning operations.

Grain Fumigation

It was next asked what precautions were necessary in the use of cyanic gas for grain fumigation.

Recommendations were: Since the gas is very hazardous to use, the first problem is to make sure all employees are out of the plant before gas is released. Only those trained in the use of this gas should be allowed to handle the project. Gas areas must be thoroughly ventilated and checked for contamination before opened for normal operations.

In considering the safe operation of power shovels for unloading grain; discussion revealed nothing new developed during the last year. It was brought out that magnetic cable is expensive and wears out too fast. Fluid drives were installed and used successfully by one plant.

The fifth question asked how to safeguard hoists at truck dumps for unloading grain.

Recommendations were: The steel chucks should be adjusted so they come up halfway on the rear wheels of the truck. One important factor was stressed—to be sure the brakes were not set before raising the truck.

It was reported that the Kewanee Co. changed the design of its installation so the chucks raise 6 in. over the center. Two accidents were reported where trucks jumped wheel chucks—one resulting in a serious injury.

Fall Type Accidents

Reduction of fall type accidents was taken up next.

One recommendation was the use of the nonskid material which could be applied to the floor, dock boards, or any slippery area. It was generally agreed that this material offers fair protection against slipping hazards.

Question seven took up controlling static electricity in solvent extraction plants.

Most companies require workers in solvent plants to wear nonconducting shoes. However, one plant found they didn't wear well if they became exposed to vegetable oils. A nonsparking metal band which clamps to the worker's shoes is used successfully in some areas.

What incentives are used to assist foremen in holding departmental safety meetings was another of the questions.

Recommendations were: Furnish each foreman with proper material for a 20-minute meeting. Those companies which have this type of program usually hold them after the close of the working day and men attending are paid overtime. One company reported that material is planned and furnished to the foremen for the whole year. Minutes of these meetings are forwarded to the safety department for whatever action is required.

In the general discussion period, the idea of developing a single sheet card for short safety talks was discussed. These cards of suitable size with a single illustration on the front facing the audience and enough pertinent information on the back covering the subject for delivering the talk will be helpful to carry out foremen's safety meetings. These cards would be inexpensive and could cover a large number of subjects useful in any safety program. These ideas appealed to the majority of those present. George Steel of Ralston Purina Co. took the floor and announced that this would be a fine project for the grain handling division to take over for the coming year. He stated he would be glad to act as the coordinator with National Safety Council to get the job done.

The problem of unloading grain from boxcars in which the floor was patched also was considered. It was brought out that some companies have recognized this hazard and posted warning signs on the grain doors on both sides of the boxcar stating the floor is patched and to use caution during unloading operations.

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What Causes Grain to Spoil?

MORE than 225 Illinois grain dealers and elevator managers got down to the fundamentals of grain spoilage recently for an answer to their increasingly important question, "What Causes Grain to Spoil?"

A series of one-day schools was held at Ottawa, Macomb, Greenville and Decatur, for the Illinois Country Grain and Feed Institute by the Business Education Service of the Board for Vocational Education with the cooperation of the University of Illinois Extension Service.

Among those on the program was Dr. M. M. MacMasters, chemist of the Northern Regional Research Laboratory, Peoria, whose research activities have been largely devoted to the structure and chemistry of cereal grains for industrial use. The theme of Dr. MacMasters' talk was that an understanding of the nature and behavior of materials being stored is fundamental to improvements in storage practice. She covered such contributory spoilage factors as molds, chemical reactions, suffocation of grain, heating and others that have brought dealers the job of not only properly storing sound grain to maintain its quality, but of handling unsound grain to keep it from getting worse.

Following are excerpts from Dr. MacMasters' discussion touching upon spoilage problems in handling grain from harvest until it eventually reaches the feed dealer, miller or industrial processor.

Weather conditions, differing from year to year, affect the state of maturity and the moisture content of the harvested grain. With corn, long-season hybrids have contributed to the amount of grain with high moisture content as also has the tendency to earlier harvesting with mechanical pickers. This means that handling of grain preparatory to and during storage must be fitted to meet modern harvesting practices. To some extent the use of combines has resulted in wheat also going into storage with higher moisture than desired.

The cereal grain kernel consists of the true seed plus outer protective layers which are called the pericarp. The pericarp is, roughly speaking, the bran; however, in some milling operations not all of the pericarp is removed, while in others, the bran contains more than just the pericarp.

The germ and endosperm are parts of the seed itself. The germ is composed of two parts, the embryonic plant, and the scutellum which acts as a nourishing organ during germination. The endosperm is the storehouse for food for the germ during germination, and it is here that most of the starch and gluten are found.

Certain structural details within the kernel are of especial interest to those concerned with storage. For example, at the upper edge of the corn kernel, above the germ, one often sees a slight peak. This is where the pollen, through the silk, entered at the time of pollination. It is believed by some that mold spores may also enter here, even before the grain starts to develop. That would account perhaps for the mold which is commonly found in the pericarp of grains.

Another possible place for mold to enter is through the relatively loose and open type of tissue that is found just under the tipcap in corn, and at the base of cereal grain kernels in general. This tissue also permits rapid entrance of moisture during tempering and steeping when the grain is milled, and probably is the exit space for water during drying. Fortunately, most of the corn kernel is covered with a thick layer of relatively waterproof material which helps to protect the seed as it lies dormant. The loose tissue at the base of the kernel is continuous with similar tissue which extends all around the kernel, forming the cross-cell layer of the pericarp, so it would not be hard for molds to grow in this entire area, and, indeed, this is where they are often found.

Under the pericarp is a thin, skin-like layer which is the seed coat of the cereal grain. At the bottom of the kernel the seed coat and some other tissues combine to form a dark, somewhat thickened structure known as the hilar layer. The latter is the black area that is readily seen when the tipcap is pulled off. The film-like seed coat and the hilar layer form an inner protective coating about the seed, offering further resistance to the entrance of microorganisms and to the movement of moisture.

Another factor contributing to the problem of drying cereal grain is the dense nature of the endosperm, where each cell is packed with starch granules which lie embedded in a matrix of proteinaceous material. In corn, too, the very size of the kernel presents a drying problem, since the outer portion may be too dry while the inner part is still very moist.

Causes of Spoilage of Grains in Storage

How grain has been handled before storage is a most important factor. If it has been allowed to deteriorate in quality, because storaged at high moisture content, for example, or it has been mishandled by allowing it to be wet by rain, its prime condition can never be restored. The best that the dealer can then do is to minimize further damage.

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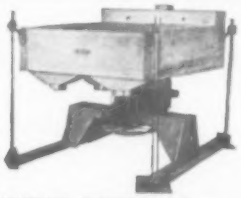

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grain is important not so much in itself but because it controls the relative humidity of the surrounding air. This is especially true at lower moisture levels. Very wet grain is a fine medium for the growth of molds, bacteria, or other microorganisms.

At the moisture levels at which grain is usually stored, the relative humidity of the air about it is extremely important. Mold growth occurs abundantly when the relative humidity is above 74 or 75%, and some kinds of mold will grow well when the relative humidity is as low as 65%. At lower relative humidities, molds may take months or even years to develop, but as soon as the relative humidity rises to about 74% or above, they develop rapidly.

The growth of microorganisms increases rapidly with increasing temperature until the heat is so great that the organisms are killed by it. For this reason, storage at low temperature is always best.

Since some molds can grow more rapidly at lower relative humidities than others, the kind of molds that are present influence the keeping quality of stored grain. It is best to assume that the most troublesome molds are present, that is, those that can grow well at low relative humidity (65%) and to act accordingly.

"Sick wheat" is a type of spoilage which sometimes results from the action of molds. In other cases, molds appear not to be responsible. Bacteria may play a part in causing sick wheat, and even suffocation of the grain itself may lead to this type of damage.

The extent to which the oil within the kernel has broken down and formed free fatty acids is important in determining the safety with which grain can be stored. The more free fatty acid present, the more likely the grain is to spoil. High content of free fatty acids indicates probably that the grain has already started to spoil, even though it does not look bad. As molds attack the grain, the free fatty acid content continues to increase.

A sound kernel is a living organism. Like other living organisms, it breathes or respires. Respiration of the grain produces some heat, just as our own breathing produces heat. If the grain is not stored so that this heat of respiration can escape, it may contribute to the heating of the stored grain.

A more serious source of heating, however, may be the presence of other living organisms in the stored grain. Molds have already been mentioned, and the effect of their respiratory heat is very marked. Insects may be an added cause of heating. Even a few insects, localized within a pocket in the grain, can heat that area considerably. The heat which they produce makes it more comfortable for them and attracts other insects to join them and enjoy the moderated temperature. When the respiration of the growing insect colony increases the temperature so much that the insects become uncomfortable, they move out to the edges, forming an ever-increasing circular zone of heating. Not only heat, but also moisture is produced by respiration. Hence the heat and moisture necessary to encourage rapid growth of molds may be centered in one zone within the grain. The molds then continue to increase the heating by their own respiration, and finally this originally small zone may become the focal point for heating of the entire bulk of the grain.

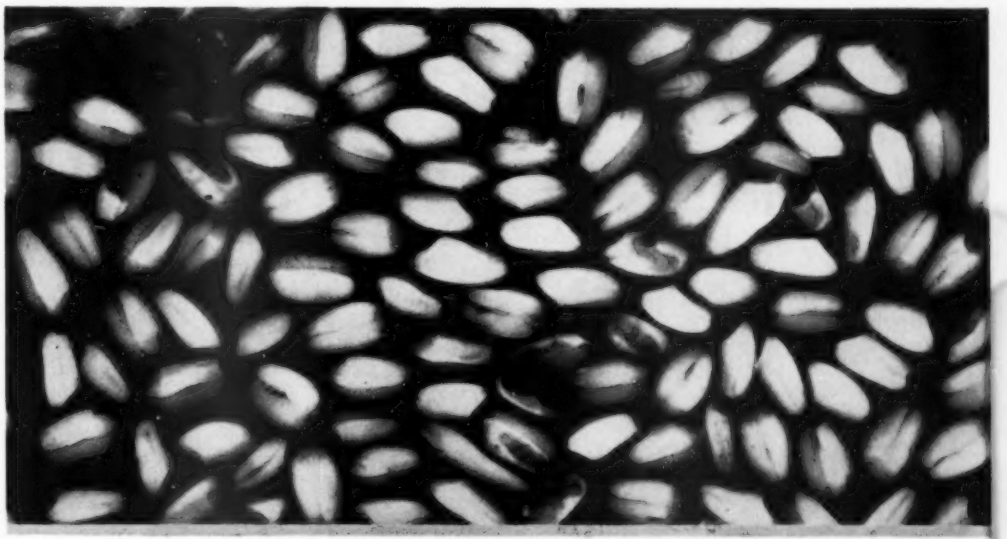
Visible Effects of Spoilage

The first evidence of spoilage is often visible mold growth. In some cases, it may be sourness which results from bacterial fermentation, but mold growth is more common.

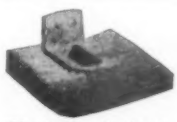
The next step is noticeable heating. Molds can heat grain to a temperature of at least 122° to 132° F. Temperatures as high as 142° F. have been reported to be caused by mold growth. Bacteria can grow at temperatures that are too high for molds, and bacteria have been reported to heat stored grain to a temperature as high as 155° to 159° F.

If heating is permitted to continue, the grain will darken and become "mahogany" colored.

During the time grain is heating, changes take place within the kernel, so that when it is cut open it looks quite unlike a kernel of sound grain. The endosperm first becomes less compact looking and appears more granular, later all evidence of the horny endosperm disappears and the entire endosperm looks very granular. Meanwhile, the germ has died.



Radiograph of infested wheat sample enlarged 3 times.



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darkened, and partially decomposed. Often mold can be seen within the germ and endosperm, as well as in the hull. If the endosperm is examined under a microscope, it can be seen that the proteinaceous material which surrounds the starch granules has partly broken down, and the starch granules may be corroded. If heating has been very high, the starch may be light tan in color and behave more like dextrin than like starch. One way of making dextrin is by heating starch, and presumably this type of change has occurred naturally when the starch has been heated to a high temperature while still in the kernel.

Methods for Controlling Spoilage

Perhaps the simplest step taken to control the spoilage of grain in storage is turning the grain to hasten its drying by air. This may give good results if the grain is not very much above the safe moisture level to start with, and if the relative humidity of the air is in the safe area, below 74%. The same is true of drying with a forced draft of unheated air.

Treatment of moist grain with chemicals to inhibit spoilage has been widely suggested and investigated on a small scale. The chemicals generally used are those with a fungistatic or fungicidal action. The result may be very good over short storage periods.

Carbon dioxide gas is sometimes used to slow down the respiration of the seed, molds, and bacteria and so inhibits heating. Although it inhibits the growth of microorganisms, it may also suffocate the grain and kill it, thus making the kernel more liable to subsequent spoilage.

Another fact must be remembered when an attempt is made to store grain at a high moisture content. That is, even if the grain does not spoil under the conditions of storage, it may still not be acceptable to a potential buyer just because of its high moisture content. Thus, dry millers of corn must have the grain at proper moisture or the right size grits will not be obtained upon milling. Wet corn millers, who produce starch, have used grain of natural high moisture content, but this has necessitated modifications in processing conditions at times. At other times, for unknown reasons, considerable difficulty has been encountered. So it is obvious that if grain is to be used for these purposes there is no advantage in holding it at high moisture content while using chemicals to prevent spoilage.

Another type of chemical treatment which may at times be advantageous is the addition of chemical drying agents to the grain. Sometimes the drying chemicals are added in pellet form; then they usually have to be screened out before the grain is used. Or wooden blocks impregnated with the drying agent may be scattered through the grain and easily removed when their work is done. When chemical drying agents are used in any form, good mixing of them with the grain is very important. Otherwise wet pockets will be left where heating can start and spread to the bulk of the grain.

Artificial Drying with Heated Air

Grain can be badly damaged by improper drying. Overheating during drying is especially dangerous. And temperature alone cannot be used as the criterion for "safe" heating. Temperature, relative humidity of the drying air, rate of air flow, moisture content of the grain, and duration of the drying treatment are closely interrelated. For example, the higher the initial moisture content of the grain and the longer the drying time, the greater is the danger from a high drying temperature. It is important to remember, too, that it is the temperature of the grain itself, rather than that of the drying air, which is of first importance. Keeping this fact in mind, certain general rules for "safe" temperatures for drying can be drawn from published information.

If corn is to be used for feeding, drying temperatures in the range of 95° to 135° F. are recommended. Higher temperatures are said to decrease the feeding value of the protein. The difference in feeding value is probably no greater than a few percentage points and may, in some cases, be offset by the practical expediency of drying at a higher temperature. Changes in the protein brought about by high temperatures probably account for the decreased feeding value which has been reported.

The safe maximum temperature allowed for drying wheat is somewhat higher than that recommended for drying corn. In Canada, the maximum temperature allowable for drying wheat is 180° F., while in England it is recommended that the temperature be not over 150° F. A difference in the average relative humidity of the atmosphere in the two countries doubtless accounts for the difference in allowed maximum drying temperature. If wheat is dried at higher temperatures, the baking quality of the flour is decreased. The wheat miller processes the wheat primarily for the baker, so it is of utmost importance to the miller that baking quality be not affected by treatment of the grain before or during storage.

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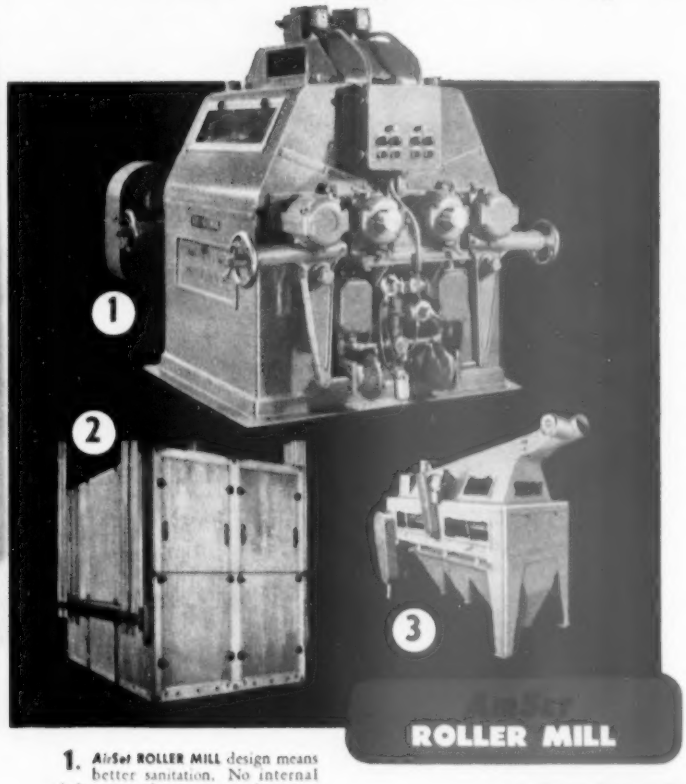

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The Use of Fungal Enzymes, a Recent Develpoment in the Technology of Baking

By Frank W. Wichser

EDITOR'S NOTE: The accompanying article is an adaptation of the text of an address delivered by Mr. Wichser at the Hard Red Winter Wheat Institute, held recently at the Oklahoma Agricultural Experiment Station, Stillwater. The author is director of products control for the Harvest Queen Mill & Elevator Co., Plainview, Texas.

MANY remarkable technical changes have come about in the baking industry within the past few years, just as advancements have been made in other industries. Not so long ago the bakery was considered a "sweat shop," because of its long hours in hot humid conditions.

The historical development of the bakery has been slow until recent years. The old bakery employed slow and manually handled batch methods for producing doughs. It has come now to a rapid and mechanical, but still batch method doughs. Quite likely in the future completely automatic and continuous processes will be developed for producing bread as well as for other baked goods products.

The 1920's saw the change from the slow speed to high speed mixing methods, using more streamlined mixers. These changes in machinery and methods were results of a demand for more bread production per unit bakery, and to cope with the tough-gluten Turkey varieties of bread wheats then available.

The Turkey-type wheats possessed a strong gluten, requiring a long sponge fermentation time and had an incredulously long mix on the slow speed mixers. The old dough break came into popular usage where a long sponge fermentation was employed along with short intensive mechanical treatment in order to condition the doughs for panning. A strong gluten type of flour was thus mandatory in order to be treated in such a harsh manner.

Approximately 20 years ago a gradual shift in the type loaf of bread began to appear. The older methods of bread baking using the strong gluten flours usually produced a loaf containing large irregular holes. Taking two dough pieces and twisting them together prior to the panning stage elongated the cell structure and tended to produce a more uniform grain devoid of the large holes. The production of doughs for twisted breads needed a more mellow gluten flour but with a substantial dough fermentation time and tolerant to high speed mixing. Even though these shop methods produced a bread of more pleasing appearance, bread containing the old time wheaty flavor was rapidly disappearing.

The era following World War II has seen another remarkable change in bakery methods and equipment. With high labor and rising basic ingredient costs, the new-built bakeries are large, well lighted, and are equipped with the most rapid, mechanized processing equipment ever seen in order to obtain the most efficient and economic bakery operation possible.

The specifications for flour have become more rigid. It has been found that the old type very strong gluten flours would not ferment and develop rapidly enough to fit into the present day shop schedule. On the other hand, a flour must possess a satisfactorily strong gluten to withstand the punishment delivered by these higher speed mixers and more fully mechanized bakery methods.

The new larger capacity higher speed mixers, dividers, rounders, molders, and other nearly fully automatic equipment have replaced the old. Traveling tunnel ovens with automatically gauged heat bake to perfection the product being produced. The baker is definitely a specialist turn-

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ing out highly specialized products. However, this changing condition again has required a little different type of flour than was available to him in years past. We are certain and sure of one thing, that wheat is grown primarily to eat, and to be eaten in the form of baked products. The manner in which it performs in the mills, and the results and success which the baker secures in preparing bread, rolls, cakes, pies, cookies and crackers that people consume are of fundamental importance in considering qualities of wheat grown. For wheat must satisfactorily fill the purpose for which it is intended if the wheat is to be "good."

Until very recently, very little specific technical research has been done for the advancement of bakery methods to attempt to utilize more flour types, rather than to have the plant breeders produce a wheat to meet the ever-changing conditions in the bakery. We know that the baker has more security in using a strong gluten type flour since the dough pieces are able to absorb and withstand severe punishment and still not be critical to handle. A long mixing tolerance type dough will generally produce a better loaf of bread than will a mellow or weak gluten flour dough with little tolerance to mixing and dough machining. However, the baker in the past has objected to the very strong gluten flours for not mellowing sufficiently in fermentation to permit dough development in the mixer to meet close shop schedule. Also, the strong gluten flours have had a tendency to become "bucky" in the time allowed for the dough piece to be processed by one machine and then to pass on to the next. Bucky doughs, not machining properly, will make up poorly on the molder and tend to produce a ragged or rough-shape appearing loaf of bread.

After eight years of comprehensive research one group of chemists has, within the past year, produced a tool which allows the baker to utilize

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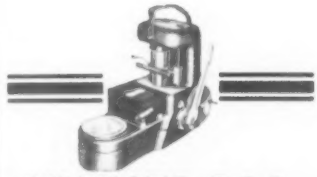

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the stronger type flours. This tool conditions or mellows the tough gluten in the doughs. The dough pieces than possess all of the desirable characteristics of a dough of long mixing tolerance, but are also mellowed for proper dough machining and handling. This research group learned how to use the purified fungal enzymes especially adapted to the bakers' use. Large scale commercial bakery operations over the country have become intensely interested in these fungal enzymes, and the enzymes have certainly proven their capabilities sufficiently for a trend to be established whereby a definite statement can be made to the plant breeder of "where to go from here"!

To describe the fungal enzymes, it's best to draw a simile to the vitamins we have been familiar with for some years, and to think in terms of vitamin tablets rather than eating particular foods to obtain the vitamins. The vitamins are specific in their actions whereby they are taken to rectify or prevent one deficiency caused by a lack of the vitamin. A number of vitamins are necessary to rectify or prevent all of the conditions relating to or resulting from over-all vitamin deficiencies. While not as many different enzymes as vitamins are needed in the baking industry, the enzymes in separate form can be utilized by the baker in the ratio of one to another as they are needed to rectify a condition. Specifically, the proteinase enzyme has formerly been tied up in an unbending ratio with the amylases in malt flour. Malt flour is a supplement that has been used in the bakery to furnish the amylase enzyme required for starch conversion, and the proteinase enzyme for modification or mellowing of the gluten. Therefore, if the baker should require more proteinase enzyme in order to mellow the gluten or reduce the size of the protein molecule by splitting connecting amino acid bonds, he would have had to add more malt flour, and in all likelihood would thereby have added an over-abundance of the amylase enzyme and not sufficient proteinase enzyme, which would subsequently produce sticky doughs because of excessive starch modification, but still have insufficient modification of the glutens. The fungal enzymes are purified enzymes and separated one from another much the same as the vitamins. Thus, the baker is able to control the amount of starch modification as well as gluten mellowing or modification by the quantity of each enzyme that he uses. Actually, sufficient proteinase enzyme can now be added to a dough which would break so many connecting amino acid bonds as to eventually liquefy the dough. The proteinase enzyme provides the baker with a tool to better condition his doughs, and especially to have accurate control over his flour gluten, even though it is inherently tough. This tool provides a new era for the baking industry and at the same time has a marked effect on the plant breeders, since tough gluten flours may cease to be any bakery problem at all. Certainly, there should be no implication here for the breeding and propagation of weaker wheats, of which we have an excess.

Wheat varieties, to furnish flour for modern bakery methods of producing bread or other baked goods, and wheat for the highly mechanized flour milling industry, must possess all of the desirable features found in our present day most acceptable wheats, but also have a greater tolerance to mixing, fermentation and dough handling. The doughs must be dry with no tendency toward stickiness or having wet surfaces that could be of serious handicap on the mixer, divider and rounder. A good quality baking flour should produce a dough having a high water absorption capacity, and a reserve of gas retention in the doughs will be inherent in such a variety. Larger loaf volume per unit weight piece of dough is being demanded, and this can only be achieved from the medium to medium long mixing requirement flours.

Comanche, closely followed by Westar, are strong gluten wheats that more closely provide the milling and baking characteristics sought in "good" wheats. Quanah is a new wheat developed for the High Plains that possesses similar characteristics to Comanche wheat. It is highly improbable that a miller or baker would obtain these varieties in pure form but, should they do so, the baker would, until recently, have experienced longer mixing time and fermentation time than could be spared economically.

The fact that the comparatively new fungal enzyme is capable of rendering the strong gluten type wheat flours to a soft, pliable dough consistency while still retaining the desired properties sought in the baked goods makes the advantages of these flours fully available to the baker.

There will always be sufficient mellow gluten wheats, such as Triumph and Wichita, having other desirable characteristics, to blend in with the Comanche, Westar and Quanah to produce the more mellow gluten doughs. The pointing of the way is clear for future work by the agronomists to retain the desirable milling and baking properties of our present mellow gluten wheats, but tend to overcome their shortcomings on gluten strength.

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A number of conclusive tests have shown that the wheat stream is the major source of fragments in freshly milled flour. It is a particularly elusive source because it is not often possible to distinguish a perfectly sound kernel of wheat from one which contains insect life. Generally, wheat is fumigated between harvest and milling. Insects in their various stages of development are thus destroyed inside the kernels. After drying out in a comparatively short time, they readily break up into small pieces when subjected to the milling processes ...Many mills have found that an alarmingly high percentage of the wheat is infested internally.

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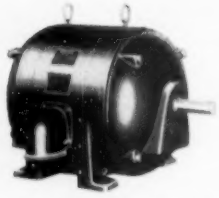

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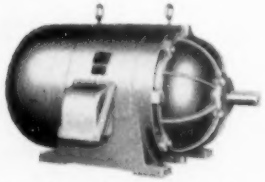

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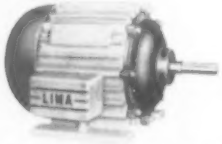

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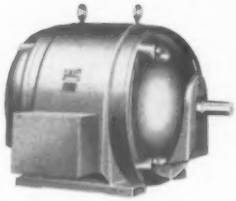

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Sanitation Program

(Continued from page 1a)

be walked around or they actually impair the operator or the equipment. There are undoubtedly places, particularly in country houses that have not been cleaned since they were built.

As was done in the basement or pit, check around the walls of the first floor level for signs of rodent activity and see that all unnecessary materials are removed so they will not provide harborages for insects and rodents. If fire barrels are placed around the elevator, make a suitable stand or rack to place them on so the floor under them can be kept clean and will not provide a place for insects to hide and breed. A relatively simple stand can be made by welding a triangular piece of angle iron together and fastening three legs about 8 in. high. This gives sufficient clearance to allow for cleaning.

Continue the inspection on the bin floor in much the same manner as previously described. While in many cases, it is unlikely that evidence of rodents will be found as high up as the top of the tanks, do not neglect to check this area thoroughly at each inspection. Cases have been observed where entire families of rodents were found living in the top of the headhouse which was well over 100 feet above the ground. Mice have also been observed as high as the scale floor in modern terminal elevators. So, do not rely on the old rule of thumb that rodents do not live above the second story.

On the bin floor check the windows for broken panes and observe any evidence of birds. Pigeons and sparrows habitually fly in and out of the tops of elevators and in the event that there are open top bins the chance of bird excrement contaminating the grain is very great. According to the information given to the grain men by George P. Larrick, associate commisisoner of the FDA, at a recent meeting in Kansas City, the food and drug inspectors will be very suspicious of such a condition.

Windows and other means of entry into such upper stories should be screened with hail screen or hardware cloth sufficiently close woven as to screen out these bird pests.

Preventing Insect Infestation

In an article with a scope as broad as this, it is impossible to give more than the basic principles and practices related to insect and rodent control. Also the methods used in large terminal elevators will be considerably different from those required in country elevator operation.

In preparing the country elevator for receiving new wheat or other grains at harvest time it is necessary to properly clean and spray the elevator bins in order to prevent infestation from beginning as soon as the grain is placed in the bin. A large majority of the elevator bins are of crib type construction and these present the greatest problem as far as reinfestation is concerned. The cadelle originally was a wood-boring insect which changed its diet somewhat when man placed a free meal in front of him. The cadelle still retains his wood-boring habits as can be seen by examining any wooden bin which has held wheat for some time.

The tunnels which the cadelle bores become filled with grain and dust and even when the bin is empty, food and lodging are provided for the dozen or so insect species which are primary grain pests. To prepare the bins properly the entire wall surface should be brushed down to remove as much dust and loose grain as possible. The bottom should also be scraped clean. The bin should then be sprayed under high pressure to force the insecticide into the holes bored by the cadelle.

Either an oil base or water base spray may be used—wettable powders are not recommended. While in the past the use of chlordane sprays has been recommended for bin spraying, the FDA advises against the use of chlordane for this purpose. If we eliminate this residual insecticide, the choice of a spray material is limited to DDT and the safer insecticides such as piperonyl butoxide-pyrethrin combination, which is often referred to as Pyrenone; Lindane, and Methoxychlor or their combinations. Elevator operators who do a lot of spray work favor the piperonyl butoxide-pyrethrin combination or Lindane. Lindane is the purified gamma isomer of benzene hexachloride from which a great deal of the objectionable odor has been removed. Lindane is usually purchased as a 20% emulsifiable concentrate which is further diluted with water or insecticidal oils, whichever is preferred.

Grain taken into a clean, sprayed elevator may have some degree of infestation present, particularly if it has been first placed in farm storage or the farmer has mixed some of last year's wheat in with the new crop. There is not a significant amount of

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actual field infestation in this area to cause concern; therefore new grain which comes in during harvest time in an infested condition has picked up that infestation after it left the field.

If grain taken in in July is to be held for 30 days or longer in any type of storage it should be fumigated. There are many brand names of fumigants on the market but the larger majority of them are of three basic types. 1. Carbon tetrachloride, ethylene dichloride, ethylene dibromide combinations. 2. Carbon tetrachloride, carbon bisulfide, ethylene dibromide combinations, and (3) carbon tetrachloride-carbon bisulfide combination. Any of these combinations are good fumigants and their dosage requirements are very similar. For wheat, dosages of 1½ gal. per 1,000 bu. in concrete or steel tanks is sufficient to pass grain inspectors but it is not sufficient to kill all the insects, particularly the hidden infestation that is the major problem. It is necessary to use a minimum of 2 gal. and in some cases 2½ gal. per 1,000 bushels in larger terminal type steel or concrete bins to do a good job. In crib type or small farm bins it is necessary to use at least double the above dosage and in some cases go as high as 5 to 6 gal., depending on the amount of grain being treated and the type of bin. In most cases it is well to follow the directions on the label.

There are many factors which may influence dosage such as temperature, type of grain, amount of dirt and dockage present, moisture of grain and most important of all is the type of bin.

A further precaution which may be a factor in holding down insect infestation in grain is the practice of spraying the cars in which the grain is to be loaded. Use the same type of spray materials that are recommended for bin spraying. Spray to thoroughly cover the floor, side walls and ends, paying particular attention to the ends and any cracks. Cars should be sprayed as far in advance of loading as is practically possible. If track space and loading schedule will allow, spray the cars the night before loading.

These same spray materials may also be used for spraying the floors, walls and tunnels of the elevator for control of roaches, silverfish and grain insects which escape from the grain stream and leaking equipment. At no time should these spray materials be used to spray directly on the grain itself.

The problem of rodent control around an elevator is often difficult, due to the location that these plants have in relation to other industries. They are often grouped together or near dumps, railyards, packing plants, etc., all of which contribute their share to the rodent problem. In some cases it will be necessary to secure the cooperation of these industries in a joint clean-up and eradication program. Such a clean-up of rodents can best be accomplished by a professional exterminator since he has materials which are not available to persons other than professionals.

After the clean-up has been accomplished, be certain that your own premises are completely cleared of trash and places of harborage as discussed earlier in the inspection program. It is then necessary to institute a continuous program of eradication. The use of the new rodenticide, Warfarin, provides a good rat and mouse killer without the extreme hazard of toxicity to the user. When used properly, Warfarin baits can be expected to do a good job of keeping down rodents. Warfarin is not a quick killer and baits must be available in sufficient quantities that the rodents may feed for at least five to 14 days. Warfarin, when taken over a period of time, destroys the blood's ability to clot and death results from internal hemmorhages. There is no bait shyness from the Warfarin itself. Baits must be fresh and not be allowed to become rancid and sour. This necessitates frequent replacement of baits. Remember Warfarin baits must be kept available to the rodents continuously.

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When you buy a BWH conveyor belt made by the *continuous* ROTOCURE process of vulcanization you obtain a *uniformly strong* belt *overall*. The weakened segments due to overlapping that sabotage operations and inflate belting costs are completely eliminated. With continuous, endless vulcanization you'll be ahead four ways:

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4. In uniform, abrasion-resistant covers

These characteristics of BWH Conveyor Belts mean minimum belt maintenance costs, longer belt life and appreciable per ton savings in the cost of what you convey! Ask your BWH distributor to show you how these highly serviceable belts can help you. Or write us direct.**

**Ask him also about BWH Rotocured Transmission Belts. Because they permit operation at lower tensions, you are assured of longest possible belt life.

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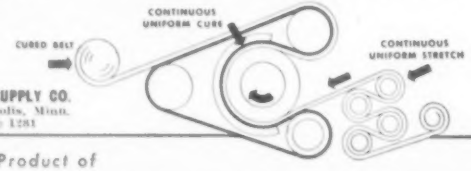

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The booklets recommend that regular inspection be followed and each carries a page on which the user can keep a maintenance record. Each booklet also has a handy reference table explaining how to locate trouble and lists possible causes and cures. Copies of the booklet may be obtained by writing Allis-Chalmers, Milwaukee, for booklets O8X7780 and O8X7813.

PAPER SACKS FOR MILLERS
The Chatfield & Woods Sack Co.
CINCINNATI O.

Electronics Engineer Studies Dielectric Grain Drying

M. P. Collom, Minneapolis representative of the Weltronic Mfg. Co., Detroit, Mich., is one man who agrees with research engineers of the U.S. Department of Agriculture when they say that dielectric heating has possibilities for grain drying.

Mr. Collom's company manufactures dielectric equipment and it is a part of his job to find new applications for its use. He read an article in the February issue of this journal which told of the results of preliminary research in the use of dielectric heating made by research engineers in the USDA.

A simple explanation of dielectric heating was supplied by Mr. Collom. He described it by saying that, "You probably have played with small bar magnets and have noticed that by switching ends of one magnet, the magnetic force repels instead of attracts the second magnet.

"That is because similar charges, either positive or negative, repel, while dissimilar charges (positive-and-negative), attract. Now, each molecule of matter is electrically charged with a protron and a neutron. Imagine the charged molecules to be small bar magnets.

"When those molecules are placed in a rapidly alternating radio frequency field, they simply get 'all hot and bothered,' switching end-for-end to keep up with the alterations of the current. Friction of the molecules generates the heat."

As the USDA engineers explained, the advantage of this type of heating is that the heat is more uniform —coming from the inside outward as well as the outside going inward. With conventional forced hot air drying, the action is similar to heating an iron rod in a forge, or baking a loaf of bread in an oven: the heat must be carried by convection from the outside of the kernel to the inside.

Low Cost Per Bushel

As a result of his research work, conducted in the amusement room of his home in Crystal, Minn., he says that he can build a dryer that will handle 1,000 bu. of wheat an hour and dry it to a safe moisture content for storage at a cost of less than .3¢ bu. He said he based his calculations on amortization of the machine over a 10-year period. That .3¢ bu. figure includes the cost of the electrical current required, plus normal electron tube replacement cost. A machine to handle 1,000 bu. an hour, he said, would cost "in the neighborhood of $40,000." A machine of that capacity might be called the king-sized model for terminal elevators. It would be a 50-kilowatt machine. His laboratory unit is a 1-kilowatt affair.

He said that his king-size drying apparatus would be equipped with a variable speed drive on the conveyor belt which would move the grain between the electron plates. The speed of the belt, he said, would be controlled automatically by the amount of moisture in the grain under the belt; if a jag of dry grain passed under the belt, it would automatically be speeded on its way, while grain with higher than average moisture would be held under the plates longer. The net result would be the delivery of grain at a uniform predetermined moisture content.

He said that the temperature of the grain can be controlled so that the drying treatment will not affect the viability, and therefore the milling quality, of the wheat.

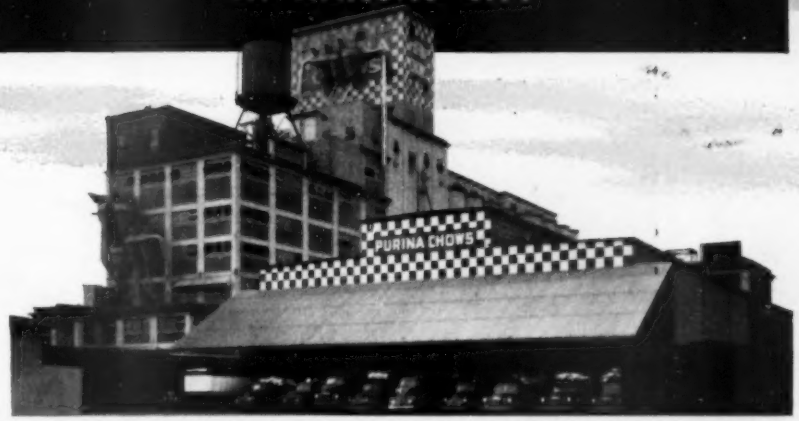
In addition to taking out excess moisture, the radio frequency heating acts as a destroyer of molds, Mr. Collom said. He had previously determined that in studying the application of dielectric heating to seed grain bearing mold and smut spores. Seed grains usually are treated with a chemical to destroy mold and smut spores previous to planting. He's ready to talk to anyone about the use of the machine as a sterilizer as well as a dryer.

Thus, the moisture in the grain is forced from the inside to be carried away by air currents, rather than to be drawn out. Another big advantage is that the temperature of the grain being dried is brought up to the desired point in the brief space of a few minutes, since the radio waves penetrate it uniformly.

Mr. Collom is confident that dielectric heating has an economically feasible commercial application for grain drying. He says that his company has applied it to a number of more complex uses.

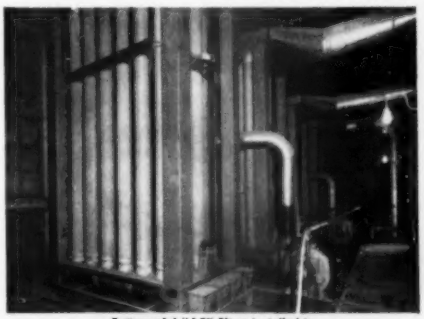
Dielectric heating is being used today for such things as drying "salted in the shell" peanuts. The unshelled

DAY-ENGINEERED DUST CONTROL SERVES RALSTON PURINA FEED PLANT AT KANSAS CITY



HIGH FEED PRODUCTION WITH EFFICIENT DUST CONTROL

"All doing a satisfactory job," says Ralston Purina with regard to the DAY Dust Control equipment installed in various of its properties. Shown here is the Purina Chows plant at Kansas City, Missouri, where a DAY Dust Control System was installed in 1951. In this plant a complete line of more than 50 poultry and animal Purina Chows are processed at the rate of 1,000 tons daily.



Battery of 4 "AC" filters installed in Ralston Purina Feed Plant at Kansas City.

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The DAY "AC" Dust Filter was designed for maximum cleaning efficiency and continuous-automatic filtering with constant air volumes. Because of its automatic cleaning mechanism, consisting of reverse air jets traveling slowly over the entire length of the tubes, the DAY "AC" Dust Filter never has to be shut down for cleaning or rapping. This maintains uniform back pressure which assures constant air volume at all times for efficient, continuous separation of dust from air.

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GRAIN - FLOUR - FEED

peanuts are soaked in a salt brine and are dried before being packed. The dielectric apparatus dries the peanuts out in minutes where it used to require hours by drying in an oven.

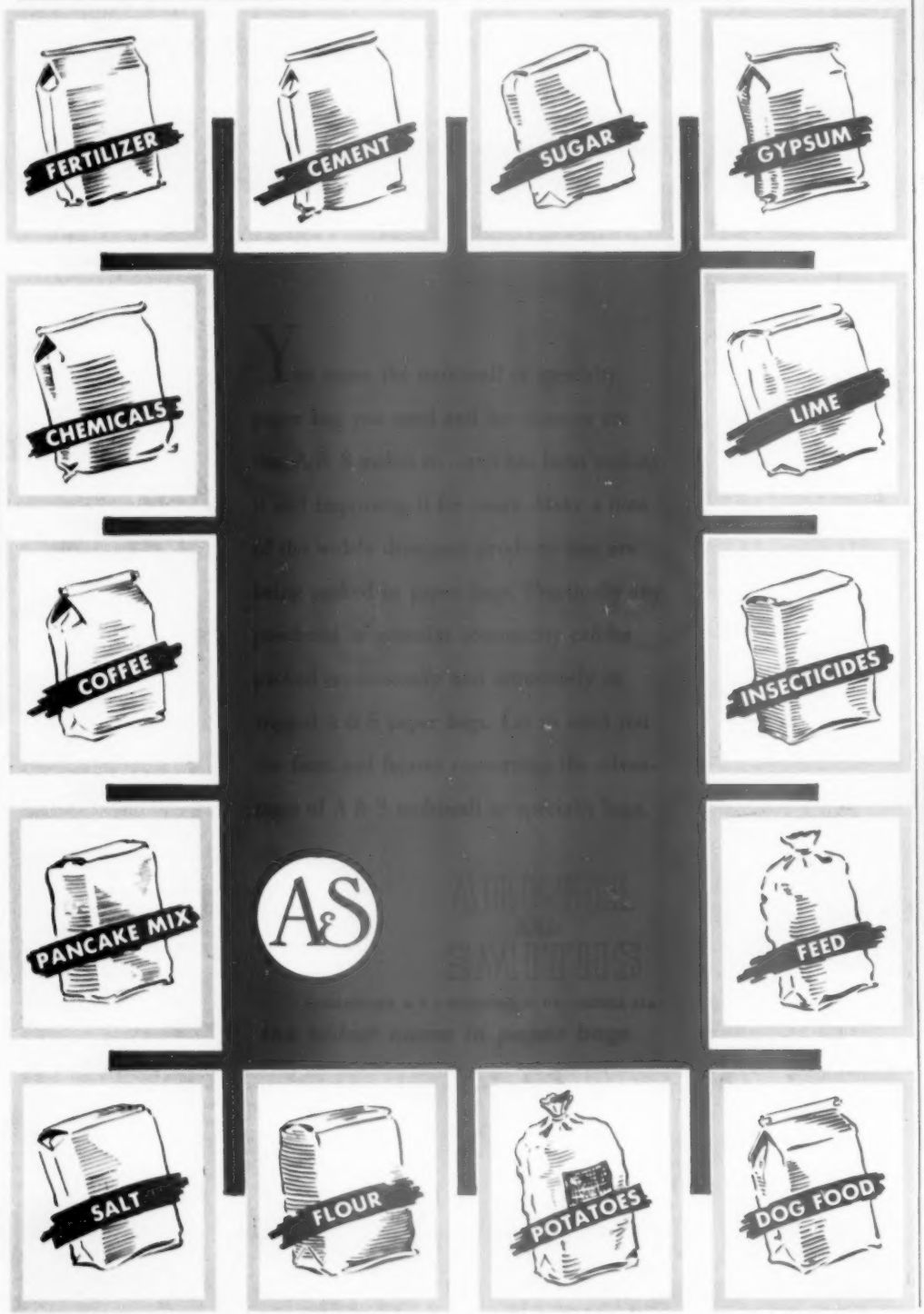
Airlines use dielectric heating to keep prepared meals warm until they are served; the plywood manufacturers use dielectric heating to laminate and glue the wood veneer. A machine is on the market which bakes wieners in pre-formed dough to produce the familiar "Coney Island" or "hot dog."

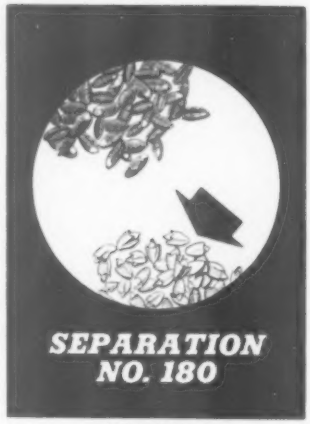
Dielectric heating is employed in the machine tool industry for countless uses, one for example, being the heat-treating for case hardening of the cutting edges of hammermill hammers. The body of the hammer remains comparatively soft and resilient while only the edge is hardened so it will last longer.

Mr. Collom has been doing some research on his own hook with a small dielectric heating unit. The Minneapolis office of the state grain inspection department has been supplying him with samples of corn, wheat, flax and rye of known moisture contents. He then uses the samples in his research, varying the time of exposure, the amount of current, the frequency, etc., until he has determined the proper settings for the machine.

"Can your machine, or a smaller machine based on the same principle, be adapted for use as a continuously recording moisture meter for wheat or flour?" Mr. Collom was asked.

"I don't know why it could not be used for that," was his response. The question was put by Prof. John M. MacKenzie, staff member in charge of the flour mill engineering curriculum at the University of Minnesota, and chairman of the Research Committee of the Association of Opera-





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FROM WHEAT

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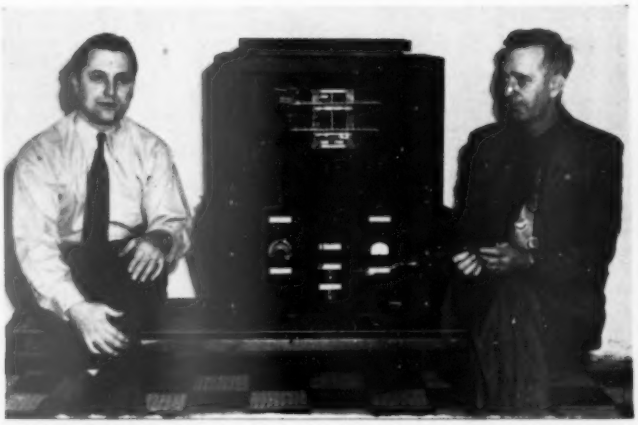

EXPERIMENTERS—Shown above is the 1-kilowatt dielectric unit that is being used in research in drying grain. M. P. Collom is shown on the right while the man on the left is Kurt Kravagna, an exchange student from Europe who is spending three months in the U.S. He is an electronics engineer and is assisting Mr. Collom with his research.

tive Millers. The result of that brief question-and-answer exchange was that the men made arrangements to get together in the near future and outline the requirements of such a device.

In any event, Mr. Collom is of the opinion that dielectric heating can be used in the drying of grain, and he is looking for an individual or a company willing to put it to a practical test. He thinks he has the answers and wants to put the information to work.

If Grandfather Were Milling Today...

he'd check the
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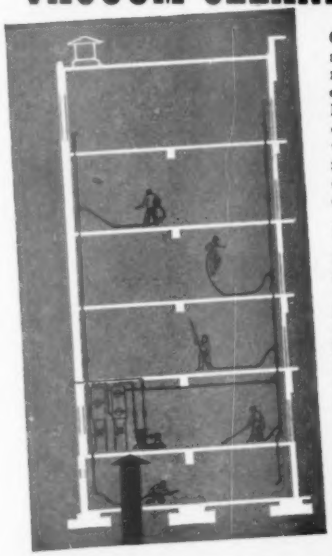

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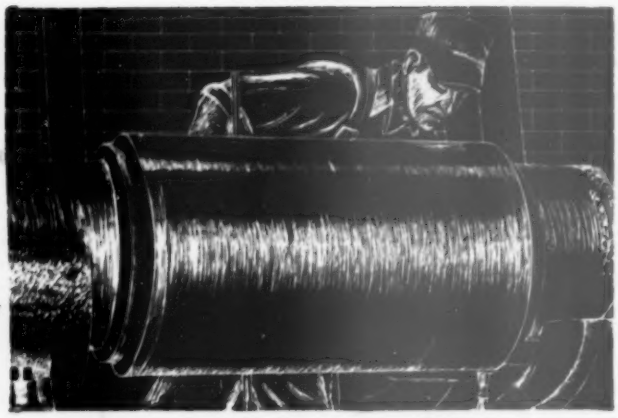

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Oklahoma Develops Promising New Hard Winter Wheat Variety

STILLWATER, OKLA.—A promising new variety of hard red winter wheat, as yet unnamed, is in the final phase of testing by the Oklahoma Agricultural Experiment Station and the seed stock may be released to approved registered and certified seed growers during the current crop year for increase.

Dr. A. M. Schlehuber, senior agronomist in charge of small grain investigations at the Experiment Station, described the new variety at the recent Winter Wheat Institute, held at Stillwater. He said that the variety has been tested on a wide scale in the region and that it has been found to have a wide regional adaptation.

It was further pointed out that preliminary milling and baking tests indicate it has acceptable milling and baking qualities.

The new strain is a hybrid cross, one parent being the result of a cross between Comanche and Blackhull, with the other parent being Hard Federation. It is No. 12517 in the Cereal Investigations register and thus far it is known simply by that number.

Going back in its pedigree, Comanche was the result of a cross between Oro and Tenmarq. Tenmarq had as its parents a strain of Turkey and Marquis. So it is evident from its pedigree that the new hybrid has many proven strains or varieties back of it.

In the Oklahoma uniform yield nurseries, the new variety has consistently been the high yielder with a grand average of 33.14 bu. an acre. Comanche ranked second with 26.83 bu., while Pawnee and Triumph averaged 24 bu. and 24.46 bu., respectively. The nursery tests were conducted at Stillwater, Woodward and Cherokee, Okla.

In plot tests at the same locations, the new variety averaged 25.97 bu. per acre and again Comanche was second with an average yield of 20.15 bu.

In the statewide variety tests for the past two crop years, the new variety averaged 23.39 bu. per acre. There were seven locations in these tests. Its average yield in 1951 was 19.76 bu., and the 1950 average was 27.01 bu. an acre.

The new variety, Dr. Schlehuber said, has ranked first in yield in 27 out of 29 tests, and had a grand average of all tests of 26.95 bu. per acre as compared with Comanche's average of 20.86 bu. for second place.

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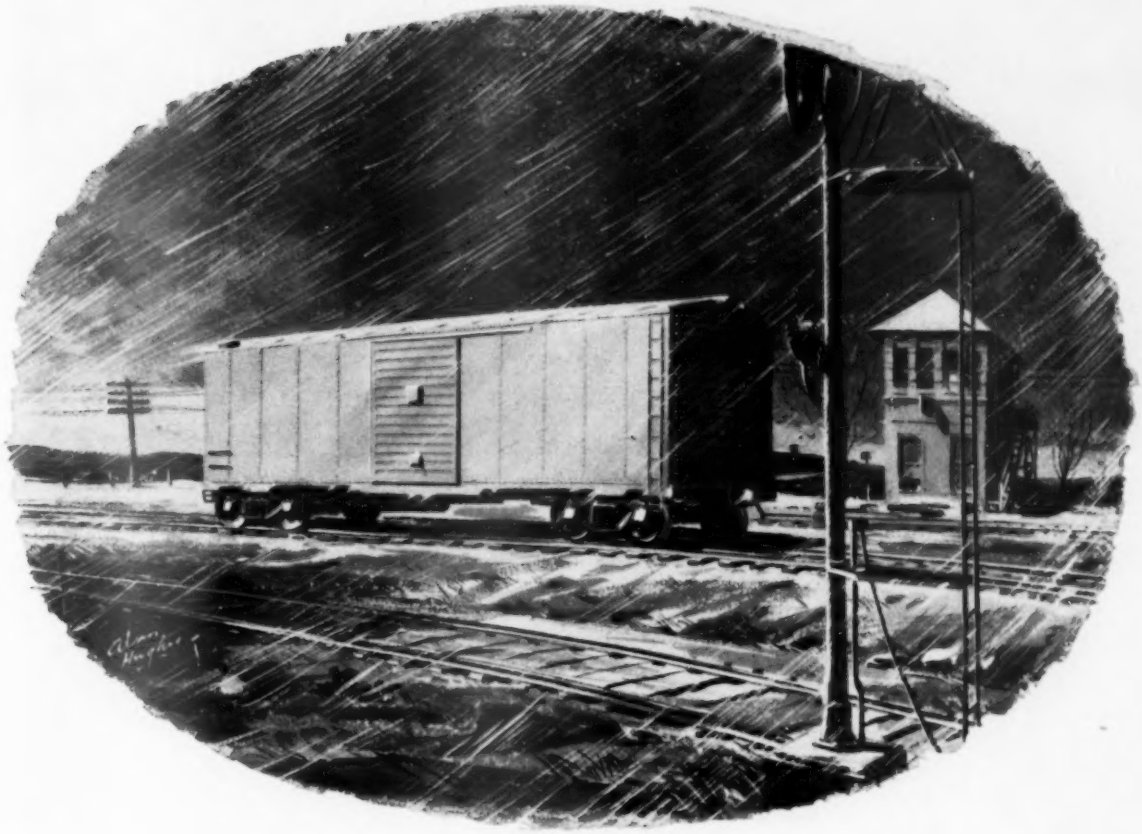

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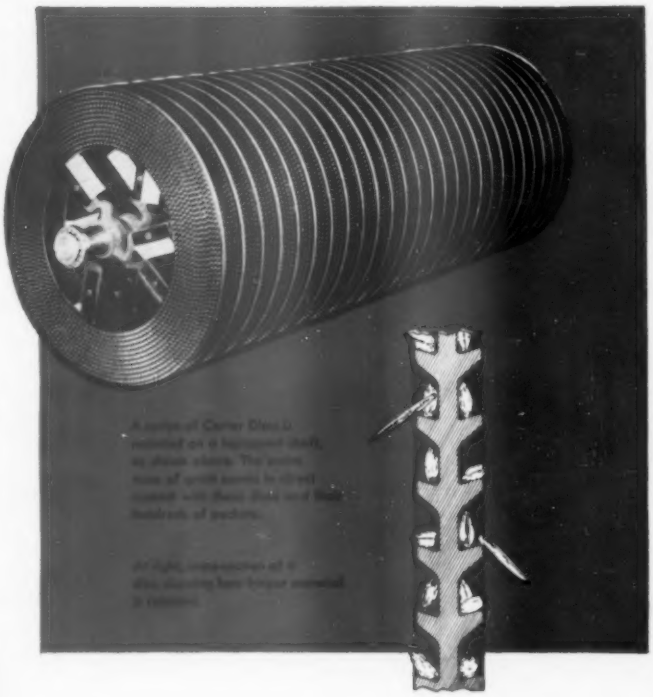

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